

## Appendix

## British Thermal Unit Conversion Factors

The thermal conversion factors presented in the following tables can be used to estimate the heat content in British thermal units (Btu) of a given amount of energy measured in physical units, such as barrels or cubic feet. For example, 10 barrels of asphalt has a heat content of approximately 66.36 million Btu (10 barrels x 6.636 million Btu per barrel = 66.36 million Btu).

The heat content rates (i.e., thermal conversion factors) provided in this section represent the gross (or higher or upper) energy content of the fuels. Gross heat content rates are applied in all Btu calculations for the *Monthly Energy Review* and are commonly used in energy calculations in the United States; net (or lower) heat content rates are typically used in European energy calculations. The difference between the two rates is the amount of energy that is consumed to vaporize water that is created during the combustion process. Generally, the difference ranges from 2 percent to 10 percent, depending on the specific fuel and its hydrogen content. Some fuels, such as unseasoned wood, can be more than 40 percent different in their gross

and net heat content rates. See "Heat Content" and "British Thermal Unit (Btu)" in the Glossary for more information.

Thermal conversion factors for hydrocarbon mixes (Table A1) are weighted averages of the thermal conversion factors for each hydrocarbon included in the mix. For example, in calculating the thermal conversion factor for a 60-40 butane-propane mixture, the thermal conversion factor for butane is weighted 1.5 times the thermal conversion factor for propane.

In general, the annual thermal conversion factors presented in Tables A2 through A6 are computed from final annual data or from the best available data and labeled "preliminary." Often, the previous year's factor is used as a preliminary value until data become available to calculate the factor appropriate to the year. The source of each factor is described in the section entitled "Thermal Conversion Factor Source Documentation," which follows Table A6 in this appendix.

**Table A1. Approximate Heat Content of Petroleum Products**  
(Million Btu per Barrel)

Petroleum Product	Heat Content	Petroleum Product	Heat Content
Asphalt	6.636	Pentanes Plus	4.620
Aviation Gasoline	5.048	Petrochemical Feedstocks	
Butane	4.326	Naptha Less Than 401°F	5.248
Butane-Propane Mixture <sup>a</sup>	4.130	Other Oils Equal to or Greater Than 401°F	5.825
Distillate Fuel Oil <sup>b</sup>	5.825	Still Gas	6.000
Ethane	3.082	Petroleum Coke	6.024
Ethane-Propane Mixture <sup>c</sup>	3.308	Plant Condensate	5.418
Isobutane	3.974	Propane	3.836
Jet Fuel, Kerosene Type	5.670	Residual Fuel Oil	6.287
Jet Fuel, Naphtha Type	5.355	Road Oil	6.636
Kerosene	5.670	Special Naphthas	5.248
Lubricants	6.065	Still Gas	6.000
Motor Gasoline <sup>d</sup>		Unfinished Oils	5.825
Conventional	5.253	Unfractionated Stream	5.418
Reformulated	5.150	Waxes	5.537
Oxygenated	5.150	Miscellaneous	5.796
Natural Gasoline and Isopentane	4.620		

<sup>a</sup> 60 percent butane and 40 percent propane.

<sup>b</sup> Does not include biodiesel. See Table A3 for biodiesel heat contents.

<sup>c</sup> 70 percent ethane and 30 percent propane.

<sup>d</sup> See Table A3 for motor gasoline weighted heat contents beginning in 1994, and for fuel ethanol heat contents.

Note: The values in this table are for gross heat contents. See "Heat Content" in Glossary.

Web Page: <http://www.eia.gov/totalenergy/data/monthly/#appendices>.

Sources: See "Thermal Conversion Factor Source Documentation," which follows Table A6.

**Table A2. Approximate Heat Content of Petroleum Production, Imports, and Exports**  
(Million Btu per Barrel)

	Production		Imports			Exports		
	Crude Oil <sup>a</sup>	Natural Gas Plant Liquids	Crude Oil <sup>a</sup>	Petroleum Products	Total	Crude Oil <sup>a</sup>	Petroleum Products	Total
1973 .....	5.800	4.049	5.817	5.983	5.897	5.800	5.752	5.752
1974 .....	5.800	4.011	5.827	5.959	5.884	5.800	5.773	5.774
1975 .....	5.800	3.984	5.821	5.935	5.858	5.800	5.747	5.748
1976 .....	5.800	3.964	5.808	5.980	5.856	5.800	5.743	5.745
1977 .....	5.800	3.941	5.810	5.908	5.834	5.800	5.796	5.797
1978 .....	5.800	3.925	5.802	5.955	5.839	5.800	5.814	5.808
1979 .....	5.800	3.955	5.810	5.811	5.810	5.800	5.864	5.832
1980 .....	5.800	3.914	5.812	5.748	5.796	5.800	5.841	5.820
1981 .....	5.800	3.930	5.818	5.659	5.775	5.800	5.837	5.821
1982 .....	5.800	3.872	5.826	5.664	5.775	5.800	5.829	5.820
1983 .....	5.800	3.839	5.825	5.677	5.774	5.800	5.800	5.800
1984 .....	5.800	3.812	5.823	5.613	5.745	5.800	5.867	5.850
1985 .....	5.800	3.815	5.832	5.572	5.736	5.800	5.819	5.814
1986 .....	5.800	3.797	5.903	5.624	5.808	5.800	5.839	5.832
1987 .....	5.800	3.804	5.901	5.599	5.820	5.800	5.860	5.858
1988 .....	5.800	3.800	5.900	5.618	5.820	5.800	5.842	5.840
1989 .....	5.800	3.826	5.906	5.641	5.833	5.800	5.869	5.857
1990 .....	5.800	3.822	5.934	5.614	5.849	5.800	5.838	5.833
1991 .....	5.800	3.807	5.948	5.636	5.873	5.800	5.827	5.823
1992 .....	5.800	3.804	5.953	5.623	5.877	5.800	5.774	5.777
1993 .....	5.800	3.801	5.954	5.620	5.883	5.800	5.777	5.779
1994 .....	5.800	3.794	5.950	5.534	5.861	5.800	5.777	5.779
1995 .....	5.800	3.796	5.938	5.483	5.855	5.800	5.740	5.746
1996 .....	5.800	3.777	5.947	5.468	5.847	5.800	5.728	5.736
1997 .....	5.800	3.762	5.954	5.469	5.862	5.800	5.726	5.734
1998 .....	5.800	3.769	5.953	5.462	5.861	5.800	5.710	5.720
1999 .....	5.800	3.744	5.942	5.421	5.840	5.800	5.684	5.699
2000 .....	5.800	3.733	5.959	5.432	5.849	5.800	5.651	5.658
2001 .....	5.800	3.735	5.976	5.443	5.862	5.800	5.751	5.752
2002 .....	5.800	3.729	5.971	5.451	5.863	5.800	5.687	5.688
2003 .....	5.800	3.739	5.970	5.438	5.857	5.800	5.739	5.740
2004 .....	5.800	3.724	5.981	5.475	5.863	5.800	5.753	5.754
2005 .....	5.800	3.724	5.977	5.474	5.845	5.800	5.741	5.743
2006 .....	5.800	3.712	5.980	5.454	5.842	5.800	5.723	5.724
2007 .....	5.800	3.701	5.985	5.503	5.862	5.800	5.749	5.750
2008 .....	5.800	3.706	5.990	5.479	5.866	5.800	5.762	5.762
2009 .....	5.800	3.692	5.988	5.525	5.882	5.800	5.737	5.738
2010 <sup>P</sup> .....	5.800	3.677	5.989	5.566	5.896	5.800	5.696	5.698
2011 <sup>E</sup> .....	5.800	3.677	5.989	5.566	5.896	5.800	5.696	5.698

<sup>a</sup> Includes lease condensate.

P=Preliminary. E=Estimate.

Note: The values in this table are for gross heat contents. See "Heat Content" in Glossary.

Web Page: <http://www.eia.gov/totalenergy/data/monthly/#appendices>.

Sources: See "Thermal Conversion Factor Source Documentation," which follows Table A6.

**Table A3. Approximate Heat Content of Petroleum Consumption and Biofuels Production**  
(Million Btu per Barrel)

	Total Petroleum <sup>a</sup> Consumption by Sector						Liquefied Petroleum Gases Consumption <sup>f</sup>	Motor Gasoline Consumption <sup>g</sup>	Fuel Ethanol <sup>h</sup>	Fuel Ethanol Feed-stock Factor <sup>i</sup>	Biodiesel	Biodiesel Feed-stock Factor <sup>j</sup>
	Residential	Commercial <sup>b</sup>	Industrial <sup>b</sup>	Transportation <sup>b,c</sup>	Electric Power <sup>d,e</sup>	Total <sup>b,c</sup>						
1973 .....	5.258	5.689	5.557	5.396	6.245	5.515	3.746	5.253	NA	NA	NA	NA
1974 .....	5.253	5.683	5.525	5.394	6.238	5.504	3.730	5.253	NA	NA	NA	NA
1975 .....	5.253	5.649	5.513	5.392	6.250	5.494	3.715	5.253	NA	NA	NA	NA
1976 .....	5.277	5.672	5.523	5.396	6.251	5.504	3.711	5.253	NA	NA	NA	NA
1977 .....	5.285	5.682	5.539	5.401	6.249	5.518	3.677	5.253	NA	NA	NA	NA
1978 .....	5.287	5.665	5.536	5.405	6.251	5.519	3.669	5.253	NA	NA	NA	NA
1979 .....	5.365	5.717	5.409	5.429	6.258	5.494	3.680	5.253	NA	NA	NA	NA
1980 .....	5.321	5.751	5.366	5.441	6.254	5.479	3.674	5.253	3.563	6.586	NA	NA
1981 .....	5.283	5.693	5.299	5.433	6.258	5.448	3.643	5.253	3.563	6.562	NA	NA
1982 .....	5.266	5.698	5.247	5.423	6.258	5.415	3.615	5.253	3.563	6.539	NA	NA
1983 .....	5.140	5.591	5.254	5.416	6.255	5.406	3.614	5.253	3.563	6.515	NA	NA
1984 .....	5.307	5.657	5.207	5.418	6.251	5.395	3.599	5.253	3.563	6.492	NA	NA
1985 .....	5.263	5.598	5.199	5.423	6.247	5.387	3.603	5.253	3.563	6.469	NA	NA
1986 .....	5.268	5.632	5.269	5.426	6.257	5.418	3.640	5.253	3.563	6.446	NA	NA
1987 .....	5.239	5.594	5.233	5.429	6.249	5.403	3.659	5.253	3.563	6.423	NA	NA
1988 .....	5.257	5.597	5.228	5.433	6.250	5.410	3.652	5.253	3.563	6.400	NA	NA
1989 .....	5.194	5.549	5.219	5.438	<sup>d</sup> 6.240	5.410	3.683	5.253	3.563	6.377	NA	NA
1990 .....	5.145	5.553	5.253	5.442	6.244	5.411	3.625	5.253	3.563	6.355	NA	NA
1991 .....	5.094	5.528	5.167	5.441	6.246	5.384	3.614	5.253	3.563	6.332	NA	NA
1992 .....	5.124	5.513	5.168	5.443	6.238	5.378	3.624	5.253	3.563	6.309	NA	NA
1993 .....	5.102	<sup>b</sup> 5.505	<sup>b</sup> 5.178	<sup>b</sup> 5.436	6.230	<sup>b</sup> 5.379	3.606	5.253	3.563	6.287	NA	NA
1994 .....	5.098	5.515	5.150	5.424	6.213	5.361	3.635	<sup>f</sup> 5.230	3.563	6.264	NA	NA
1995 .....	5.063	5.478	5.121	5.417	6.188	5.341	3.623	5.215	3.563	6.242	NA	NA
1996 .....	4.998	5.433	5.114	5.420	6.195	5.336	3.613	5.216	3.563	6.220	NA	NA
1997 .....	4.989	5.391	5.120	5.416	6.199	5.336	3.616	5.213	3.563	6.198	NA	NA
1998 .....	4.975	5.365	5.137	5.413	6.210	5.349	3.614	5.212	3.563	6.176	NA	NA
1999 .....	4.902	5.291	5.092	5.413	6.205	5.328	3.616	5.211	3.563	6.167	NA	NA
2000 .....	4.908	5.316	5.057	5.422	6.189	5.326	3.607	5.210	3.563	6.159	NA	NA
2001 .....	4.937	5.325	5.142	5.412	6.199	5.345	3.614	5.210	3.563	6.151	5.359	5.433
2002 .....	4.886	5.293	5.093	5.411	6.173	5.324	3.613	5.208	3.563	6.143	5.359	5.433
2003 .....	4.907	5.307	5.142	5.409	6.182	5.340	3.629	5.207	3.563	6.116	5.359	5.433
2004 .....	4.953	5.328	5.144	5.421	6.192	5.350	3.618	5.215	3.563	6.089	5.359	5.433
2005 .....	4.916	5.364	5.178	5.427	6.188	5.365	3.620	5.218	3.563	6.063	5.359	5.433
2006 .....	4.894	5.310	5.160	5.431	6.143	5.353	3.605	5.218	3.563	6.036	5.359	5.433
2007 .....	4.850	5.298	5.127	5.434	6.151	5.346	3.591	5.219	3.563	6.009	5.359	5.433
2008 .....	4.732	5.175	5.149	5.426	6.123	5.339	3.600	5.218	3.563	5.983	5.359	5.433
2009 .....	4.691	5.266	5.018	<sup>c</sup> 5.414	6.105	<sup>c</sup> 5.301	3.558	5.218	3.563	5.957	5.359	5.433
2010 .....	<sup>E</sup> 4.701	<sup>E</sup> 5.280	<sup>E</sup> 5.014	<sup>E</sup> 5.420	<sup>P</sup> 6.085	<sup>P</sup> 5.300	<sup>P</sup> 3.558	<sup>P</sup> 5.218	<sup>P</sup> 3.561	<sup>P</sup> 5.930	5.359	5.433
2011 .....	<sup>E</sup> 4.701	<sup>E</sup> 5.280	<sup>E</sup> 5.014	<sup>E</sup> 5.420	<sup>E</sup> 6.085	<sup>E</sup> 5.300	<sup>E</sup> 3.558	<sup>E</sup> 5.218	<sup>E</sup> 3.561	<sup>E</sup> 5.904	5.359	5.433

<sup>a</sup> Petroleum products supplied, including natural gas plant liquids and crude oil burned directly as fuel. Quantity-weighted averages of the petroleum products included in each category are calculated by using heat content values shown in Table A1.

<sup>b</sup> Beginning in 1993, includes fuel ethanol blended into motor gasoline.

<sup>c</sup> Beginning in 2009, includes renewable diesel fuel (including biodiesel) blended into distillate fuel oil.

<sup>d</sup> Electricity-only and combined-heat-and-power (CHP) plants within the NAICS 22 category whose primary business is to sell electricity, or electricity and heat, to the public. Through 1988, data are for electric utilities only; beginning in 1989, data are for electric utilities and independent power producers.

<sup>e</sup> Electric power sector factors are weighted average heat contents for distillate fuel oil, petroleum coke, and residual fuel oil; they exclude other liquids.

<sup>f</sup> Quantity-weighted averages of the major components of liquefied petroleum gases are calculated by using heat content values shown in Table A1.

<sup>g</sup> There is a discontinuity in this time series between 1993 and 1994; beginning in 1994, the single constant factor is replaced by a quantity-weighted factor—quantity-weighted averages of the major components of motor gasoline, including fuel ethanol, are calculated by using heat content values shown in Table A3.

<sup>h</sup> Includes denaturant (petroleum added to ethanol to make it undrinkable). Fuel ethanol factors are weighted average heat contents for undenatured ethanol (3.539 million Btu per barrel), pentanes plus used as denaturant (4.620 million Btu per barrel), and conventional motor gasoline and motor gasoline blending components used as denaturant (5.253 million Btu per barrel). The factor for 2009 is used as the estimated factor for 1980-2008.

<sup>i</sup> Corn input to the production of undenatured ethanol (million Btu corn per barrel undenatured ethanol), used as the factor to estimate total biomass inputs to the production of undenatured ethanol. Observed ethanol yields (gallons undenatured ethanol per bushel of corn) are 2.5 in 1980, 2.666 in 1998, 2.68 in 2002, and 2.764 in 2009; yields in other years are estimated. Corn is assumed to have a gross heat content of 0.392 million Btu per bushel. Undenatured ethanol is assumed to have a gross heat content of 3.539 million Btu per barrel.

<sup>j</sup> Soybean oil input to the production of biodiesel (million Btu soybean oil per barrel biodiesel), used as the factor to estimate total biomass inputs to the production of biodiesel. It is assumed that 7.65 pounds of soybean oil are needed to produce one gallon of biodiesel, and 5.433 million Btu of soybean oil are needed to produce one barrel of biodiesel. Soybean oil is assumed to have a gross heat content of 16,909 Btu per pound, or 5.483 million Btu per barrel. Biodiesel is assumed to have a gross heat content of 17,253 Btu per pound, or 5.359 million Btu per barrel.

P=Preliminary. E=Estimate. NA=Not available.

Note: The heat content values in this table are for gross heat contents. See "Heat Content" in Glossary.

Web Page: <http://www.eia.gov/totalenergy/data/monthly/#appendices>.

Sources: See "Thermal Conversion Factor Source Documentation," which follows Table A6.

**Table A4. Approximate Heat Content of Natural Gas**  
(Btu per Cubic Foot)

	Production		Consumption <sup>a</sup>			Imports	Exports
	Marketed	Dry	End-Use Sectors <sup>b</sup>	Electric Power Sector <sup>c</sup>	Total		
1973 .....	1,093	1,021	1,020	1,024	1,021	1,026	1,023
1974 .....	1,097	1,024	1,024	1,022	1,024	1,027	1,016
1975 .....	1,095	1,021	1,020	1,026	1,021	1,026	1,014
1976 .....	1,093	1,020	1,019	1,023	1,020	1,025	1,013
1977 .....	1,093	1,021	1,019	1,029	1,021	1,026	1,013
1978 .....	1,088	1,019	1,016	1,034	1,019	1,030	1,013
1979 .....	1,092	1,021	1,018	1,035	1,021	1,037	1,013
1980 .....	1,098	1,026	1,024	1,035	1,026	1,022	1,013
1981 .....	1,103	1,027	1,025	1,035	1,027	1,014	1,011
1982 .....	1,107	1,028	1,026	1,036	1,028	1,018	1,011
1983 .....	1,115	1,031	1,031	1,030	1,031	1,024	1,010
1984 .....	1,109	1,031	1,030	1,035	1,031	1,005	1,010
1985 .....	1,112	1,032	1,031	1,038	1,032	1,002	1,011
1986 .....	1,110	1,030	1,029	1,034	1,030	997	1,008
1987 .....	1,112	1,031	1,031	1,032	1,031	999	1,011
1988 .....	1,109	1,029	1,029	1,028	1,029	1,002	1,018
1989 .....	1,107	1,031	1,031	<sup>c</sup> 1,028	1,031	1,004	1,019
1990 .....	1,105	1,029	1,030	1,027	1,029	1,012	1,018
1991 .....	1,108	1,030	1,031	1,025	1,030	1,014	1,022
1992 .....	1,110	1,030	1,031	1,025	1,030	1,011	1,018
1993 .....	1,106	1,027	1,028	1,025	1,027	1,020	1,016
1994 .....	1,105	1,028	1,029	1,025	1,028	1,022	1,011
1995 .....	1,106	1,026	1,027	1,021	1,026	1,021	1,011
1996 .....	1,109	1,026	1,027	1,020	1,026	1,022	1,011
1997 .....	1,107	1,026	1,027	1,020	1,026	1,023	1,011
1998 .....	1,109	1,031	1,033	1,024	1,031	1,023	1,011
1999 .....	1,107	1,027	1,028	1,022	1,027	1,022	1,006
2000 .....	1,107	1,025	1,026	1,021	1,025	1,023	1,006
2001 .....	1,105	1,028	1,029	1,026	1,028	1,023	1,010
2002 .....	1,106	1,027	1,029	1,020	1,027	1,022	1,008
2003 .....	1,106	1,028	1,029	1,025	1,028	1,025	1,009
2004 .....	1,104	1,026	1,026	1,027	1,026	1,025	1,009
2005 .....	1,104	1,028	1,028	1,028	1,028	1,025	1,009
2006 .....	1,103	1,028	1,028	1,028	1,028	1,025	1,009
2007 .....	1,104	1,029	1,030	1,027	1,029	1,025	1,009
2008 .....	1,100	1,027	1,027	1,027	1,027	1,025	1,009
2009 .....	1,101	1,025	1,025	1,025	1,025	1,025	1,009
2010 .....	<sup>E</sup> 1,101	<sup>E</sup> 1,024	<sup>E</sup> 1,025	<sup>P</sup> 1,022	<sup>E</sup> 1,024	<sup>E</sup> 1,025	<sup>E</sup> 1,009
2011 .....	<sup>E</sup> 1,101	<sup>E</sup> 1,024	<sup>E</sup> 1,025	<sup>E</sup> 1,022	<sup>E</sup> 1,024	<sup>E</sup> 1,025	<sup>E</sup> 1,009

<sup>a</sup> Consumption factors are for natural gas, plus a small amount of supplemental gaseous fuels.

<sup>b</sup> Residential, commercial, industrial, and transportation sectors.

<sup>c</sup> Electricity-only and combined-heat-and-power (CHP) plants within the NAICS 22 category whose primary business is to sell electricity, or electricity and heat, to the public. Through 1988, data are for electric utilities only; beginning in 1989, data are for electric utilities and independent power producers.

P=Preliminary. E=Estimate.

Note: The values in this table are for gross heat contents. See "Heat Content" in Glossary.

Web Page: <http://www.eia.gov/totalenergy/data/monthly/#appendices>.

Sources: See "Thermal Conversion Factor Source Documentation," which follows Table A6.

**Table A5. Approximate Heat Content of Coal and Coal Coke**

(Million Btu per Short Ton)

	Coal									Coal Coke
	Production <sup>a</sup>	Waste Coal Supplied <sup>b</sup>	Consumption					Imports	Exports	Imports and Exports
			Residential and Commercial Sectors	Industrial Sector		Electric Power Sector <sup>d,e</sup>	Total			
				Coke Plants	Other <sup>c</sup>					
1973 .....	23.376	NA	22.831	26.780	22.586	22.246	23.057	25.000	26.596	24.800
1974 .....	23.072	NA	22.479	26.778	22.419	21.781	22.677	25.000	26.700	24.800
1975 .....	22.897	NA	22.261	26.782	22.436	21.642	22.506	25.000	26.562	24.800
1976 .....	22.855	NA	22.774	26.781	22.530	21.679	22.498	25.000	26.601	24.800
1977 .....	22.597	NA	22.919	26.787	22.322	21.508	22.265	25.000	26.548	24.800
1978 .....	22.248	NA	22.466	26.789	22.207	21.275	22.017	25.000	26.478	24.800
1979 .....	22.454	NA	22.242	26.788	22.452	21.364	22.100	25.000	26.548	24.800
1980 .....	22.415	NA	22.543	26.790	22.690	21.295	21.947	25.000	26.384	24.800
1981 .....	22.308	NA	22.474	26.794	22.585	21.085	21.713	25.000	26.160	24.800
1982 .....	22.239	NA	22.695	26.797	22.712	21.194	21.674	25.000	26.223	24.800
1983 .....	22.052	NA	22.775	26.798	22.691	21.133	21.576	25.000	26.291	24.800
1984 .....	22.010	NA	22.844	26.799	22.543	21.101	21.573	25.000	26.402	24.800
1985 .....	21.870	NA	22.646	26.798	22.020	20.959	21.366	25.000	26.307	24.800
1986 .....	21.913	NA	22.947	26.798	22.198	21.084	21.462	25.000	26.292	24.800
1987 .....	21.922	NA	23.404	26.799	22.381	21.136	21.517	25.000	26.291	24.800
1988 .....	21.823	NA	23.571	26.799	22.360	20.900	21.328	25.000	26.299	24.800
1989 .....	21.765	<sup>b</sup> 10.391	23.650	26.800	22.347	<sup>d</sup> 20.898	21.307	25.000	26.160	24.800
1990 .....	21.822	9.303	23.137	26.799	22.457	20.779	21.197	25.000	26.202	24.800
1991 .....	21.681	10.758	23.114	26.799	22.460	20.730	21.120	25.000	26.188	24.800
1992 .....	21.682	10.396	23.105	26.799	22.250	20.709	21.068	25.000	26.161	24.800
1993 .....	21.418	10.638	22.994	26.800	22.123	20.677	21.010	25.000	26.335	24.800
1994 .....	21.394	11.097	23.112	26.800	22.068	20.589	20.929	25.000	26.329	24.800
1995 .....	21.326	11.722	23.118	26.800	21.950	20.543	20.880	25.000	26.180	24.800
1996 .....	21.322	12.147	23.011	26.800	22.105	20.547	20.870	25.000	26.174	24.800
1997 .....	21.296	12.158	22.494	26.800	22.172	20.518	20.830	25.000	26.251	24.800
1998 .....	21.418	12.639	21.620	27.426	23.164	20.516	20.881	25.000	26.800	24.800
1999 .....	21.070	12.552	23.880	27.426	22.489	20.490	20.818	25.000	26.081	24.800
2000 .....	21.072	12.360	25.020	27.426	22.433	20.511	20.828	25.000	26.117	24.800
2001 .....	<sup>a</sup> 20.772	12.169	24.909	27.426	22.622	20.337	20.671	25.000	25.998	24.800
2002 .....	20.673	12.165	22.962	27.426	22.562	20.238	20.541	25.000	26.062	24.800
2003 .....	20.499	12.360	22.242	27.425	22.468	20.082	20.387	25.000	25.972	24.800
2004 .....	20.424	12.266	22.324	27.426	22.473	19.980	20.290	25.000	26.108	24.800
2005 .....	20.348	12.093	22.342	26.279	22.178	19.988	20.246	25.000	25.494	24.800
2006 .....	20.310	12.080	22.066	26.271	22.050	19.931	20.181	25.000	25.453	24.800
2007 .....	20.340	12.090	22.069	26.329	22.371	19.909	20.168	25.000	25.466	24.800
2008 .....	20.208	12.121	21.887	26.281	22.348	19.713	19.977	25.000	25.399	24.800
2009 .....	19.969	11.862	22.059	26.334	21.893	19.521	19.742	25.000	25.633	24.800
2010 <sup>P</sup> .....	20.192	11.755	21.254	26.296	21.909	19.612	19.858	25.000	25.713	24.800
2011 <sup>E</sup> .....	20.192	11.755	21.254	26.296	21.909	19.612	19.858	25.000	25.713	24.800

<sup>a</sup> Beginning in 2001, includes a small amount of refuse recovery (coal recaptured from a refuse mine, and cleaned to reduce the concentration of noncombustible materials).

<sup>b</sup> Waste coal (including fine coal, coal obtained from a refuse bank or slurry dam, anthracite culm, bituminous gob, and lignite waste) consumed by the electric power and industrial sectors. Beginning in 1989, waste coal supplied is counted as a supply-side item to balance the same amount of waste coal included in "Consumption."

<sup>c</sup> Includes transportation. Excludes coal synfuel plants.

<sup>d</sup> Electricity-only and combined-heat-and-power (CHP) plants within the NAICS 22 category whose primary business is to sell electricity, or electricity and heat, to the public. Through 1988, data are for electric utilities only; beginning in 1989, data are for electric utilities and independent power producers.

<sup>e</sup> Electric power sector factors are for anthracite, bituminous coal, subbituminous coal, lignite, waste coal, and, beginning in 1998, coal synfuel.

P=Preliminary. E=Estimate. NA=Not available.

Note: The values in this table are for gross heat contents. See "Heat Content" in Glossary.

Web Page: <http://www.eia.gov/totalenergy/data/monthly/#appendices>.

Sources: See "Thermal Conversion Factor Source Documentation," which follows Table A6.

**Table A6. Approximate Heat Rates for Electricity, and Heat Content of Electricity**  
(Btu per Kilowatthour)

	Approximate Heat Rates <sup>a</sup> for Electricity Net Generation			Heat Content <sup>f</sup> of Electricity <sup>g</sup>
	Fossil Fuels <sup>b,c</sup>	Nuclear <sup>d</sup>	Geothermal <sup>e</sup>	
1973 .....	10,389	10,903	21,674	3,412
1974 .....	10,442	11,161	21,674	3,412
1975 .....	10,406	11,013	21,611	3,412
1976 .....	10,373	11,047	21,611	3,412
1977 .....	10,435	10,769	21,611	3,412
1978 .....	10,361	10,941	21,611	3,412
1979 .....	10,353	10,879	21,545	3,412
1980 .....	10,388	10,908	21,639	3,412
1981 .....	10,453	11,030	21,639	3,412
1982 .....	10,454	11,073	21,629	3,412
1983 .....	10,520	10,905	21,290	3,412
1984 .....	10,440	10,843	21,303	3,412
1985 .....	10,447	10,622	21,263	3,412
1986 .....	10,446	10,579	21,263	3,412
1987 .....	10,419	10,442	21,263	3,412
1988 .....	10,324	10,602	21,096	3,412
1989 .....	10,432	10,583	21,096	3,412
1990 .....	10,402	10,582	21,096	3,412
1991 .....	10,436	10,484	20,997	3,412
1992 .....	10,342	10,471	20,914	3,412
1993 .....	10,309	10,504	20,914	3,412
1994 .....	10,316	10,452	20,914	3,412
1995 .....	10,312	10,507	20,914	3,412
1996 .....	10,340	10,503	20,960	3,412
1997 .....	10,213	10,494	20,960	3,412
1998 .....	10,197	10,491	21,017	3,412
1999 .....	10,226	10,450	21,017	3,412
2000 .....	10,201	10,429	21,017	3,412
2001 .....	<sup>c</sup> 10,333	10,443	21,017	3,412
2002 .....	10,173	10,442	21,017	3,412
2003 .....	10,241	10,421	21,017	3,412
2004 .....	10,022	10,427	21,017	3,412
2005 .....	9,999	10,436	21,017	3,412
2006 .....	9,919	10,436	21,017	3,412
2007 .....	9,884	10,485	21,017	3,412
2008 .....	9,854	10,453	21,017	3,412
2009 .....	9,760	10,460	21,017	3,412
2010 .....	<sup>E</sup> 9,760	<sup>E</sup> 10,460	<sup>E</sup> 21,017	3,412
2011 .....	<sup>E</sup> 9,760	<sup>E</sup> 10,460	<sup>E</sup> 21,017	3,412

<sup>a</sup> The values in columns 1–3 of this table are for net heat rates. See "Heat Rate" in Glossary.

<sup>b</sup> Used as the thermal conversion factor for hydro, geothermal, solar thermal/photovoltaic, and wind electricity net generation to approximate the quantity of fossil fuels replaced by these sources. Through 2000, also used as the thermal conversion factor for wood and waste electricity net generation at electric utilities; beginning in 2001, Btu data for wood and waste at electric utilities are available from surveys.

<sup>c</sup> Through 2000, heat rates are for fossil-fueled steam-electric plants at electric utilities. Beginning in 2001, heat rates are for all fossil-fueled plants at electric utilities and electricity-only independent power producers.

<sup>d</sup> Used as the thermal conversion factor for nuclear electricity net generation.

<sup>e</sup> Technology-based thermal conversion factors for geothermal electricity net generation. Beginning with the April 2011 *Monthly Energy Review*, the technology-based geothermal heat rates are no longer used in Btu calculations in this report, but they are retained on this table for purposes of comparison.

<sup>f</sup> See "Heat Content" in Glossary.

<sup>g</sup> The value of 3,412 Btu per kilowatthour is a constant. It is used as the thermal conversion factor for electricity retail sales, and electricity imports and exports.

<sup>E</sup>=Estimate.

Web Page: <http://www.eia.gov/totalenergy/data/monthly/#appendices>.

Sources: See "Thermal Conversion Factor Source Documentation," which follows this table.

# Thermal Conversion Factor Source Documentation

## Approximate Heat Content of Petroleum and Natural Gas Plant Liquids

**Asphalt.** The U.S. Energy Information Administration (EIA) adopted the thermal conversion factor of 6.636 million British thermal units (Btu) per barrel as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*.

**Aviation Gasoline.** EIA adopted the thermal conversion factor of 5.048 million Btu per barrel as adopted by the Bureau of Mines from the Texas Eastern Transmission Corporation publication *Competition and Growth in American Energy Markets 1947–1985*, a 1968 release of historical and projected statistics.

**Butane.** EIA adopted the Bureau of Mines thermal conversion factor of 4.326 million Btu per barrel as published in the *California Oil World and Petroleum Industry*, First Issue, April 1942.

**Butane-Propane Mixture.** EIA adopted the Bureau of Mines calculation of 4.130 million Btu per barrel based on an assumed mixture of 60 percent butane and 40 percent propane. See **Butane** and **Propane**.

**Crude Oil Exports.** Assumed by EIA to be 5.800 million Btu per barrel or equal to the thermal conversion factor for crude oil produced in the United States. See **Crude Oil Production**.

**Crude Oil Imports.** Calculated annually by EIA as the average of the thermal conversion factors for each type of crude oil imported weighted by the quantities imported. Thermal conversion factors for each type were calculated on a foreign country basis, by determining the average American Petroleum Institute (API) gravity of crude oil imported from each foreign country from Form ERA-60 in 1977 and converting average API gravity to average Btu content by using National Bureau of Standards, Miscellaneous Publication No. 97, *Thermal Properties of Petroleum Products*, 1933.

**Crude Oil Production.** EIA adopted the thermal conversion factor of 5.800 million Btu per barrel as reported in a Bureau of Mines internal memorandum, “Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950.”

**Distillate Fuel Oil.** EIA adopted the Bureau of Mines thermal conversion factor of 5.825 million Btu per barrel as reported in a Bureau of Mines internal memorandum, “Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950.”

**Ethane.** EIA adopted the Bureau of Mines thermal conversion factor of 3.082 million Btu per barrel as published in the *California Oil World and Petroleum Industry*, First Issue, April 1942.

**Ethane-Propane Mixture.** EIA calculation of 3.308 million Btu per barrel based on an assumed mixture of 70 percent ethane and 30 percent propane. See **Ethane** and **Propane**.

**Isobutane.** EIA adopted the Bureau of Mines thermal conversion factor of 3.974 million Btu per barrel as published in the *California Oil World and Petroleum Industry*, First Issue, April 1942.

**Jet Fuel, Kerosene-Type.** EIA adopted the Bureau of Mines thermal conversion factor of 5.670 million Btu per barrel for “Jet Fuel, Commercial” as published by the Texas Eastern Transmission Corporation in the report *Competition and Growth in American Energy Markets 1947–1985*, a 1968 release of historical and projected statistics.

**Jet Fuel, Naphtha-Type.** EIA adopted the Bureau of Mines thermal conversion factor of 5.355 million Btu per barrel for “Jet Fuel, Military” as published by the Texas Eastern Transmission Corporation in the report *Competition and Growth in American Energy Markets 1947–1985*, a 1968 release of historical and projected statistics.

**Kerosene.** EIA adopted the Bureau of Mines thermal conversion factor of 5.670 million Btu per barrel as reported in a Bureau of Mines internal memorandum, “Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950.”

**Liquefied Petroleum Gases Consumption.** Calculated annually by EIA as the average of the thermal conversion factors for all liquefied petroleum gases consumed (see Table A1) weighted by the quantities consumed. The component products of liquefied petroleum gases are ethane (including ethylene), propane (including propylene), normal butane (including butylene), butane-propane mixtures, ethane-propane mixtures, and isobutane. For 1973–1980, quantities consumed are from EIA, Energy Data Reports, “Petroleum Statement, Annual,” Table 1. For 1981 forward, quantities consumed are from EIA, *Petroleum Supply Annual*, Table 2.

**Lubricants.** EIA adopted the thermal conversion factor of 6.065 million Btu per barrel as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*.

**Miscellaneous Products.** EIA adopted the thermal conversion factor of 5.796 million Btu per barrel as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*.

**Motor Gasoline Consumption.** 1973–1993: EIA adopted the Bureau of Mines thermal conversion factor of 5.253 million Btu per barrel for “Gasoline, Motor Fuel” as published by the Texas Eastern Transmission Corporation in Appendix V of *Competition and Growth in American Energy Markets 1947–1985*, a 1968 release of historical and projected statistics. 1994 forward: EIA calculated national annual quantity-weighted average conversion factors for conventional, reformulated, and oxygenated motor gasolines (see Table A3). The factor for conventional motor gasoline is 5.253 million Btu per barrel, as used for

previous years. The factors for reformulated and oxygenated gasolines, both currently 5.150 million Btu per barrel, are based on data published in Environmental Protection Agency, Office of Mobile Sources, National Vehicle and Fuel Emissions Laboratory report EPA 420-F-95-003, "Fuel Economy Impact Analysis of Reformulated Gasoline." See **Fuel Ethanol (Denatured)**.

**Natural Gas Plant Liquids Production.** Calculated annually by EIA as the average of the thermal conversion factors for each natural gas plant liquid produced weighted by the quantities produced.

**Natural Gasoline.** EIA adopted the thermal conversion factor of 4.620 million Btu per barrel as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*.

**Pentanes Plus.** EIA assumed the thermal conversion factor to be 4.620 million Btu or equal to that for natural gasoline. See **Natural Gasoline**.

**Petrochemical Feedstocks, Naphtha less than 401° F.** Assumed by EIA to be 5.248 million Btu per barrel, equal to the thermal conversion factor for special naphthas. See **Special Naphthas**.

**Petrochemical Feedstocks, Other Oils equal to or greater than 401° F.** Assumed by EIA to be 5.825 million Btu per barrel, equal to the thermal conversion factor for distillate fuel oil. See **Distillate Fuel Oil**.

**Petrochemical Feedstocks, Still Gas.** Assumed by EIA to be 6.000 million Btu per barrel, equal to the thermal conversion factor for still gas. See **Still Gas**.

**Petroleum Coke.** EIA adopted the thermal conversion factor of 6.024 million Btu per barrel as reported in Btu per short ton in the Bureau of Mines internal memorandum, "Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950." The Bureau of Mines calculated this factor by dividing 30.120 million Btu per short ton, as given in the referenced Bureau of Mines internal memorandum, by 5.0 barrels per short ton, as given in the Bureau of Mines Form 6-1300-M and successor EIA forms.

**Petroleum Consumption, Commercial Sector.** Calculated annually by EIA as the average of the thermal conversion factors for all petroleum products consumed by the commercial sector weighted by the estimated quantities consumed by the commercial sector. The quantities of petroleum products consumed by the commercial sector are estimated in the State Energy Data System—see documentation at [http://www.eia.gov/states/sep\\_use/notes/use\\_petrol.pdf](http://www.eia.gov/states/sep_use/notes/use_petrol.pdf).

**Petroleum Consumption, Electric Power Sector.** Calculated annually by EIA as the average of the thermal

conversion factors for all petroleum products consumed by the electric power sector weighted by the quantities consumed by the electric power sector. Data are from Form EIA-923, "Power Plant Operations Report," and predecessor forms.

**Petroleum Consumption, Industrial Sector.** Calculated annually by EIA as the average of the thermal conversion factors for all petroleum products consumed by the industrial sector weighted by the estimated quantities consumed by the industrial sector. The quantities of petroleum products consumed by the industrial sector are estimated in the State Energy Data System—see documentation at [http://www.eia.gov/states/sep\\_use/notes/use\\_petrol.pdf](http://www.eia.gov/states/sep_use/notes/use_petrol.pdf).

**Petroleum Consumption, Residential Sector.** Calculated annually by EIA as the average of the thermal conversion factors for all petroleum products consumed by the residential sector weighted by the estimated quantities consumed by the residential sector. The quantities of petroleum products consumed by the residential sector are estimated in the State Energy Data System—see documentation at [http://www.eia.gov/states/sep\\_use/notes/use\\_petrol.pdf](http://www.eia.gov/states/sep_use/notes/use_petrol.pdf).

**Petroleum Consumption, Total.** Calculated annually by EIA as the average of the thermal conversion factors for all petroleum products consumed weighted by the quantities consumed.

**Petroleum Consumption, Transportation Sector.** Calculated annually by EIA as the average of the thermal conversion factors for all petroleum products consumed by the transportation sector weighted by the estimated quantities consumed by the transportation sector. The quantities of petroleum products consumed by the transportation sector are estimated in the State Energy Data System—see documentation at [http://www.eia.gov/states/sep\\_use/notes/use\\_petrol.pdf](http://www.eia.gov/states/sep_use/notes/use_petrol.pdf).

**Petroleum Products Exports.** Calculated annually by EIA as the average of the thermal conversion factors for each petroleum product exported weighted by the quantities exported.

**Petroleum Products Imports.** Calculated annually by EIA as the average of the thermal conversion factors for each petroleum product imported weighted by the quantities imported.

**Plant Condensate.** Estimated to be 5.418 million Btu per barrel by EIA from data provided by McClanahan Consultants, Inc., Houston, Texas.

**Propane.** EIA adopted the Bureau of Mines thermal conversion factor of 3.836 million Btu per barrel as published in the *California Oil World and Petroleum Industry*, First Issue, April 1942.

**Residual Fuel Oil.** EIA adopted the thermal conversion factor of 6.287 million Btu per barrel as reported in the



Bureau of Mines internal memorandum, "Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950."

**Road Oil.** EIA adopted the Bureau of Mines thermal conversion factor of 6.636 million Btu per barrel, which was assumed to be equal to that of asphalt (see **Asphalt**) and was first published by the Bureau of Mines in the *Petroleum Statement, Annual, 1970*.

**Special Naphthas.** EIA adopted the Bureau of Mines thermal conversion factor of 5.248 million Btu per barrel, which was assumed to be equal to that of the total gasoline (aviation and motor) factor and was first published in the *Petroleum Statement, Annual, 1970*.

**Still Gas.** EIA adopted the Bureau of Mines estimated thermal conversion factor of 6.000 million Btu per barrel, first published in the *Petroleum Statement, Annual, 1970*.

**Total Petroleum Exports.** Calculated annually by EIA as the average of the thermal conversion factors for crude oil and each petroleum product exported weighted by the quantities exported. See **Crude Oil Exports** and **Petroleum Products Exports**.

**Total Petroleum Imports.** Calculated annually by EIA as the average of the thermal conversion factors for each type of crude oil and petroleum product imported weighted by the quantities imported. See **Crude Oil Imports** and **Petroleum Products Imports**.

**Unfinished Oils.** EIA assumed the thermal conversion factor to be 5.825 million Btu per barrel or equal to that for distillate fuel oil (see **Distillate Fuel Oil**) and first published it in EIA's *Annual Report to Congress, Volume 3, 1977*.

**Unfractionated Stream.** EIA assumed the thermal conversion factor to be 5.418 million Btu per barrel or equal to that for plant condensate (see **Plant Condensate**) and first published it in EIA's *Annual Report to Congress, Volume 2, 1981*.

**Waxes.** EIA adopted the thermal conversion factor of 5.537 million Btu per barrel as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*.

## Approximate Heat Content of Biofuels

**Biodiesel.** EIA estimated the thermal conversion factor for biodiesel to be 5.359 million Btu per barrel, or 17,253 Btu per pound.

**Biodiesel Feedstock.** EIA used soybean oil input to the production of biodiesel (million Btu soybean oil per barrel biodiesel) as the factor to estimate total biomass inputs to the production of biodiesel. EIA assumed that 7.65 pounds

of soybean oil are needed to produce one gallon of biodiesel, and 5.433 million Btu of soybean oil are needed to produce one barrel of biodiesel. EIA also assumed that soybean oil has a gross heat content of 16,909 Btu per pound, or 5.483 million Btu per barrel.

**Ethanol (Undenatured).** EIA adopted the thermal conversion factor of 3.539 million Btu per barrel published in "Oxygenate Flexibility for Future Fuels," a paper presented by William J. Piel of the ARCO Chemical Company at the National Conference on Reformulated Gasolines and Clean Air Act Implementation, Washington, D.C., October 1991.

**Fuel Ethanol (Denatured).** 1981–2008: EIA used the 2009 factor. 2009 forward: Calculated by EIA as the annual quantity-weighted average of the thermal conversion factors for undenatured ethanol (3.539 million Btu per barrel), pentanes plus used as denaturant (4.620 million Btu per barrel), and conventional motor gasoline and motor gasoline blending components used as denaturant (5.253 million Btu per barrel). The quantity of ethanol consumed is from EIA's *Petroleum Supply Annual (PSA)* and *Petroleum Supply Monthly (PSM)*, Table 1, data for renewable fuels and oxygenate plant net production of fuel ethanol. The quantity of pentanes plus used as denaturant is from PSA/PSM, Table 1, data for renewable fuels and oxygenate plant net production of pentanes plus, multiplied by -1. The quantity of conventional motor gasoline and motor gasoline blending components used as denaturant is from PSA/PSM, Table 1, data for renewable fuels and oxygenate plant net production of conventional motor gasoline and motor gasoline blending components, multiplied by -1.

**Fuel Ethanol Feedstock.** EIA used corn input to the production of undenatured ethanol (million Btu corn per barrel undenatured ethanol) as the annual factor to estimate total biomass inputs to the production of undenatured ethanol. U.S. Department of Agriculture observed ethanol yields (gallons undenatured ethanol per bushel of corn) were 2.5 in 1980, 2.666 in 1998, 2.68 in 2002, and 2.764 in 2009; EIA estimated the ethanol yields in other years. EIA also assumed that corn has a gross heat content of 0.392 million Btu per bushel.

## Approximate Heat Content of Natural Gas

**Natural Gas Consumption, Electric Power Sector.** Calculated annually by EIA by dividing the heat content of natural gas consumed by the electric power sector by the quantity consumed. Data are from Form EIA-923, "Power Plant Operations Report," and predecessor forms.

**Natural Gas Consumption, End-Use Sectors.** Calculated annually by EIA by dividing the heat content of natural gas consumed by the end-use sectors (residential, commercial,

industrial, and transportation) by the quantity consumed. Data are from Form EIA-176, “Annual Report of Natural and Supplemental Gas Supply and Disposition.”

**Natural Gas Consumption, Total.** 1973–1979: EIA adopted the thermal conversion factor calculated annually by the American Gas Association (AGA) and published in *Gas Facts*, an AGA annual publication. 1980 forward: Calculated annually by EIA by dividing the total heat content of natural gas consumed by the total quantity consumed.

**Natural Gas Exports.** Calculated annually by EIA by dividing the heat content of natural gas exported by the quantity exported. For 1973–1995, data are from Form FPC-14, “Annual Report for Importers and Exporters of Natural Gas.” Beginning in 1996, data are from U.S. Department of Energy, Office of Fossil Energy, *Natural Gas Imports and Exports*.

**Natural Gas Imports.** Calculated annually by EIA by dividing the heat content of natural gas imported by the quantity imported. For 1973–1995, data are from Form FPC-14, “Annual Report for Importers and Exporters of Natural Gas.” Beginning in 1996, data are from U.S. Department of Energy, Office of Fossil Energy, *Natural Gas Imports and Exports*.

**Natural Gas Production, Dry.** Assumed by EIA to be equal to the thermal conversion factor for dry natural gas consumed. See **Natural Gas Consumption, Total**.

**Natural Gas Production, Marketed.** Calculated annually by EIA by dividing the heat content of dry natural gas produced (see **Natural Gas Production, Dry**) and natural gas plant liquids produced (see **Natural Gas Plant Liquids Production**) by the total quantity of marketed natural gas produced.

## Approximate Heat Content of Coal and Coal Coke

**Coal Coke Imports and Exports.** EIA adopted the Bureau of Mines estimate of 24,800 million Btu per short ton.

**Coal Consumption, Electric Power Sector.** Calculated annually by EIA by dividing the heat content of coal consumed by the electric power sector by the quantity consumed. Data are from Form EIA-923, “Power Plant Operations Report,” and predecessor forms.

**Coal Consumption, Industrial Sector, Coke Plants.** Calculated annually by EIA by dividing the heat content of coal consumed by coke plants by the quantity consumed. Data are from Form EIA-5, “Quarterly Coal Consumption and Quality Report—Coke Plants.”

**Coal Consumption, Industrial Sector, Other.** Calculated annually by EIA by dividing the heat content of coal consumed by manufacturing plants by the quantity consumed. Data are from Form EIA-3, “Quarterly Coal Consumption and Quality Report—Manufacturing Plants.”

**Coal Consumption, Residential and Commercial Sectors.** Calculated annually by EIA by dividing the heat content of coal consumed by the residential and commercial sectors by the quantity consumed. Through 1999, data are from Form EIA-6, “Coal Distribution Report.” Beginning in 2000, data are for commercial combined-heat-and-power (CHP) plants from Form EIA-923, “Power Plant Operations Report,” and predecessor forms.

**Coal Consumption, Total.** Calculated annually by EIA by dividing the total heat content of coal consumed by all sectors by the total quantity consumed.

**Coal Exports.** Calculated annually by EIA by dividing the heat content of steam coal and metallurgical coal exported by the quantity exported. Data are from U.S. Department of Commerce, Bureau of the Census, “Monthly Report EM 545.”

**Coal Imports.** Assumed by EIA to be 25,000 million Btu per short ton.

**Coal Production.** Calculated annually by EIA to balance the heat content of coal supply (production and imports) and the heat content of coal disposition (exports, stock change, and consumption).

**Waste Coal Supplied.** Calculated annually by EIA by dividing the total heat content of waste coal supplied by the quantity supplied. For 1989–1997, data are from Form EIA-867, “Annual Nonutility Power Producer Report.” For 1998–2000, data are from Form EIA-860B, “Annual Electric Generator Report—Nonutility.” For 2001 forward, data are from Form EIA-3, “Quarterly Coal Consumption and Quality Report—Manufacturing Plants”; Form EIA-923, “Power Plant Operations Report”; and predecessor forms.

## Approximate Heat Rates for Electricity

**Electricity Net Generation, Fossil Fuels.** There is no generally accepted practice for measuring the thermal conversion rates for power plants that generate electricity from hydro, geothermal, solar thermal, photovoltaic, and wind energy sources. Therefore, EIA calculates a rate factor that is equal to the annual average heat rate factor for fossil-fueled power plants in the United States. By using that factor, it is possible to evaluate fossil fuel requirements for replacing those sources during periods of interruption, such as droughts. The heat content of a kilowatthour of electricity produced, regardless of the generation process, is 3,412 Btu. 1973–1988: The weighted annual average heat rate for fossil-fueled

steam-electric power plants in the United States, as published in EIA, *Electric Plant Cost and Power Production Expenses 1991*, Table 9. 1989–2000: Calculated annually by EIA by using the heat rate data reported on Form EIA-860, “Annual Electric Generator Report” (and predecessor forms); and net generation data reported on Form EIA-759, “Monthly Power Plant Report.” The computation includes data for all electric utility steam-electric plants using fossil fuels. 2001 forward: Calculated annually by EIA by using fuel consumption and net generation data reported on Form EIA-923, “Power Plant Operations Report,” and predecessor forms. The computation includes data for all electric utilities and electricity-only independent power producers using fossil fuels.

**Electricity Net Generation, Geothermal.** 1973–1981: Calculated annually by EIA by weighting the annual average heat rates of operating geothermal units by the installed nameplate capacities as reported on Form FPC-12, “Power System Statement.” 1982 forward: Estimated annually by EIA on the basis of an informal survey of relevant plants. Beginning with the April 2011

*Monthly Energy Review*, the technology-based geothermal heat rates are no longer used in Btu calculations in this report, but they are retained on Table A6 for purposes of comparison.

**Electricity Net Generation, Nuclear.** 1973–1984: Calculated annually by dividing the total heat content consumed in nuclear generating units by the total (net) electricity generated by nuclear generating units. The heat content and electricity generation were reported on Form FERC-1, “Annual Report of Major Electric Utilities, Licensees, and Others”; Form EIA-412, “Annual Report of Public Electric Utilities”; and predecessor forms. For 1982, the factors were published in EIA, *Historical Plant Cost and Annual Production Expenses for Selected Electric Plants 1982*, page 215. For 1983 and 1984, the factors were published in EIA, *Electric Plant Cost and Power Production Expenses 1991*, Table 13. 1985 forward: Calculated annually by EIA by using the heat rate reported on Form EIA-860, “Annual Electric Generator Report” (and predecessor forms), and the generation reported on Form EIA-923, “Power Plant Operations Report” (and predecessor forms).



## Metric Conversion Factors, Metric Prefixes, and Other Physical Conversion Factors

Data presented in the *Monthly Energy Review* and in other U.S. Energy Information Administration publications are expressed predominately in units that historically have been used in the United States, such as British thermal units, barrels, cubic feet, and short tons. However, because U.S. commerce involves other nations, most of which use metric units of measure, the U.S. Government is committed to the transition to the metric system, as stated in the Metric Conversion Act of 1975 (Public Law 94–168), amended by the Omnibus Trade and Competitiveness Act of 1988 (Public Law 100–418), and Executive Order 12770 of July 25, 1991.

The metric conversion factors presented in Table B1 can be used to calculate the metric-unit equivalents of values expressed in U.S. Customary units. For example, 500 short

tons are the equivalent of 453.6 metric tons (500 short tons x 0.9071847 metric tons/short ton = 453.6 metric tons).

In the metric system of weights and measures, the names of multiples and subdivisions of any unit may be derived by combining the name of the unit with prefixes, such as deka, hecto, and kilo, meaning, respectively, 10, 100, 1,000, and deci, centi, and milli, meaning, respectively, one-tenth, one-hundredth, and one-thousandth. Common metric prefixes can be found in Table B2.

The conversion factors presented in Table B3 can be used to calculate equivalents in various physical units commonly used in energy analyses. For example, 10 barrels are the equivalent of 420 U.S. gallons (10 barrels x 42 gallons/barrel = 420 gallons).

**Table B1. Metric Conversion Factors**

Type of Unit	U.S. Unit		Equivalent in	Metric Units
<b>Mass</b>	1 short ton (2,000 lb)	=	0.907 184 7	metric tons (t)
	1 long ton	=	1.016 047	metric tons (t)
	1 pound (lb)	=	0.453 592 37 <sup>a</sup>	kilograms (kg)
	1 pound uranium oxide (lb U <sub>3</sub> O <sub>8</sub> )	=	0.384 647 <sup>b</sup>	kilograms uranium (kgU)
	1 ounce, avoirdupois (avdp oz)	=	28.349 52	grams (g)
<b>Volume</b>	1 barrel of oil (bbl)	=	0.158 987 3	cubic meters (m <sup>3</sup> )
	1 cubic yard (yd <sup>3</sup> )	=	0.764 555	cubic meters (m <sup>3</sup> )
	1 cubic foot (ft <sup>3</sup> )	=	0.028 316 85	cubic meters (m <sup>3</sup> )
	1 U.S. gallon (gal)	=	3.785 412	liters (L)
	1 ounce, fluid (fl oz)	=	29.573 53	milliliters (mL)
	1 cubic inch (in <sup>3</sup> )	=	16.387 06	milliliters (mL)
<b>Length</b>	1 mile (mi)	=	1.609 344 <sup>a</sup>	kilometers (km)
	1 yard (yd)	=	0.914 4 <sup>a</sup>	meters (m)
	1 foot (ft)	=	0.304 8 <sup>a</sup>	meters (m)
	1 inch (in)	=	2.54 <sup>a</sup>	centimeters (cm)
<b>Area</b>	1 acre	=	0.404 69	hectares (ha)
	1 square mile (mi <sup>2</sup> )	=	2.589 988	square kilometers (km <sup>2</sup> )
	1 square yard (yd <sup>2</sup> )	=	0.836 127 4	square meters (m <sup>2</sup> )
	1 square foot (ft <sup>2</sup> )	=	0.092 903 04 <sup>a</sup>	square meters (m <sup>2</sup> )
	1 square inch (in <sup>2</sup> )	=	6.451 6 <sup>a</sup>	square centimeters (cm <sup>2</sup> )
<b>Energy</b>	1 British thermal unit (Btu) <sup>c</sup>	=	1,055.055 852 62 <sup>a</sup>	joules (J)
	1 calorie (cal)	=	4.186 8 <sup>a</sup>	joules (J)
	1 kilowatthour (kWh)	=	3.6 <sup>a</sup>	megajoules (MJ)
<b>Temperature<sup>d</sup></b>	32 degrees Fahrenheit (°F)	=	0 <sup>a</sup>	degrees Celsius (°C)
	212 degrees Fahrenheit (°F)	=	100 <sup>a</sup>	degrees Celsius (°C)

<sup>a</sup>Exact conversion.

<sup>b</sup>Calculated by the U.S. Energy Information Administration.

<sup>c</sup>The Btu used in this table is the International Table Btu adopted by the Fifth International Conference on Properties of Steam, London, 1956.

<sup>d</sup>To convert degrees Fahrenheit (°F) to degrees Celsius (°C) exactly, subtract 32, then multiply by 5/9.

Notes: • Spaces have been inserted after every third digit to the right of the decimal for ease of reading. • Most metric units belong to the International System of Units (SI), and the liter, hectare, and metric ton are accepted for use with the SI units. For more information about the SI units, see <http://physics.nist.gov/cuu/Units/index.html>.

Web Page: <http://www.eia.gov/totalenergy/data/monthly/#appendices>.

Sources: • General Services Administration, Federal Standard 376B, *Preferred Metric Units for General Use by the Federal Government* (Washington, DC, January 1993), pp. 9-11, 13, and 16. • U.S. Department of Commerce, National Institute of Standards and Technology, Special Publications 330, 811, and 814. • American National Standards Institute/Institute of Electrical and Electronic Engineers, ANSI/IEEE Std 268-1992, pp. 28 and 29.

**Table B2. Metric Prefixes**

Unit Multiple	Prefix	Symbol	Unit Subdivision	Prefix	Symbol
10 <sup>1</sup>	deka	da	10 <sup>-1</sup>	deci	d
10 <sup>2</sup>	hecto	h	10 <sup>-2</sup>	centi	c
10 <sup>3</sup>	kilo	k	10 <sup>-3</sup>	milli	m
10 <sup>6</sup>	mega	M	10 <sup>-6</sup>	micro	μ
10 <sup>9</sup>	giga	G	10 <sup>-9</sup>	nano	n
10 <sup>12</sup>	tera	T	10 <sup>-12</sup>	pico	p
10 <sup>15</sup>	peta	P	10 <sup>-15</sup>	femto	f
10 <sup>18</sup>	exa	E	10 <sup>-18</sup>	atto	a
10 <sup>21</sup>	zetta	Z	10 <sup>-21</sup>	zepto	z
10 <sup>24</sup>	yotta	Y	10 <sup>-24</sup>	yocto	y

Web Page: <http://www.eia.gov/totalenergy/data/monthly/#appendices>.

Source: U.S. Department of Commerce, National Institute of Standards and Technology, *The International System of Units (SI)*, NIST Special Publication 330, 1991 Edition (Washington, DC, August 1991), p.10.

**Table B3. Other Physical Conversion Factors**

Energy Source	Original Unit		Equivalent in Final Units
<b>Petroleum</b>	1 barrel (bbl)	=	42 <sup>a</sup> U.S. gallons (gal)
<b>Coal</b>	1 short ton	=	2,000 <sup>a</sup> pounds (lb)
	1 long ton	=	2,240 <sup>a</sup> pounds (lb)
	1 metric ton (t)	=	1,000 <sup>a</sup> kilograms (kg)
<b>Wood</b>	1 cord (cd)	=	1.25 <sup>b</sup> shorts tons
	1 cord (cd)	=	128 <sup>a</sup> cubic feet (ft <sup>3</sup> )

<sup>a</sup>Exact conversion.

<sup>b</sup>Calculated by the U.S. Energy Information Administration.

Web Page: <http://www.eia.gov/totalenergy/data/monthly/#appendices>.

Source: U.S. Department of Commerce, National Institute of Standards and Technology, *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*, NIST Handbook 44, 1994 Edition (Washington, DC, October 1993), pp. B-10, C-17 and C-21.